IFW AF/3723 #

Attorney's Docket No. F-03278c PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:		Skeem et al.	
Serial No.:	08/892,836	Group No.:	3723
Filed:	7/15/97	Examiner:	Nguyen
for:	Metal Single Layer Abrasive Cutting Tool Having A Contoured Cutting Surface		

Mail Stop Appeal Brief-Patents
Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL OF APPEAL BRIEF (PATENT APPLICATION-37 CFR 1.192)

1. Transmitted herewith in triplicate is the APPEAL BRIEF in this application with respect to the notice of Appeal filed on March 29, 2004

NOTE: "Appellant must, within 2 months from the date of the notice of appeal under § 1.191 or within the time allowed for reply to the action appealed from which the appeal was taken(a), if such time is later, file a brief **in triplicate.**" 37 CFR 1.192 [emphasis added].

2. **STATUS OF APPLICANT**

This application is on behalf of

[X] other than a small entity

[ ] small entity
verified statement:

[ ] attached

[ ] already filed.

3. **FEE FOR FILING APPEAL BRIEF**

Pursuant to 37 CFR 1.17(c) the fee for filing the Appeal Brief is:

[ ] small entity	$ 165.00
[X] other than a small entity	$ 330.00
Appeal Brief fee due	**$ 330.00**

05/21/2004 AWONDAF1 00000114 141400 08892836

01 FC:1253 530.00 DA

CERTIFICATE OF MAILING (37 CFR 1.8a)

I hereby certify that this paper (along with any referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to the: Commissioner for Patents, PO Box 1450, Alexandria, VA 22313-1450

Date: May 18, 2004

Suzanne G. Gendreau
(Typed or print name of person mailing paper)

05/21/2004 AWONDAF1 ~~00000098 08892836~~

~~02 FC:2253 530.00 DA~~

Suzanne G. Gendreau
(Signature of person mailing paper)

4. EXTENSION OF TERM

NOTE: The time periods set forth in 37 CFR 1.192(a) are subject to the provision of § 1.136 for patent application 37 CFR 1.191(d). Also see Notice of November 5, 1985 (1060 O.G. 27).

The proceedings herein are for a patent application and the provisions of 37 CFR 1.136 apply.

(complete (a) or (b) as applicable)

(a) [X] Applicant petitions for an extension of time under 37 CFR 1.136 (fees:37CRF 1.17(a)(1)-(5)) for the total number of months checked below:

	Extension (months)	Fee for other than small entity	Fee for small entity
[ ]	one month	$ 110.00	$ 55.00
[ ]	two months	$ 420.00	$210.00
X	three months	$ 950.00	$475.00
[ ]	four months	$1,480.00	$740.00
[ ]	five months	$2,010.00	$1,005.00

Fee $ 950.00

If an additional extension of time is required please consider this a petition therefor.

(check and complete the next item, if applicable)

[X] An extension for 2 months has already been secured and the fee paid therefor of $ 420 is deducted from the total fee due for the total months of extension now requested.

Extension fee due with this request $ 530.00

OR

(b) [ ] Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

5. TOTAL FEE DUE

The total fee due is:

Appeal brief fee $ 330.00

Extension fee (if any) $ 530.00

TOTAL FEE DUE $ 860.00

6. FEE PAYMENT

[ ] Attached is a check in the sum of $__________.

[x] Charge Account No. 14-1400 the sum of $ 860.00 .

A duplicate of this transmittal is attached

7. **FEE DEFICIENCY**

NOTE: If there is a fee deficiency and there is no authorization to charge an account, additional fees are necessary to cover the additional time consumed in making up the original deficiency. If the maximum, six-month period has expired before the deficiency is noted and corrected, the applicaion is held abandoned. In those instances where authorization to charge is included, processing delays are encountered in returning the papers to the PTO Finance Branch in order to apply these charges prior to action on the cases. Authorization to change the deposit account for any fee deficiency should be checked. See the **Notice of April 7, 1986**, 1065 O.G. 31-33.

[X] If any additional extension and/or fee is required, this is a request therefor and to charge Account No. 14-1400.

AND/OR

[ ] If any additional fee for claims is required, charge Account No. 14-1400 .

Mary E. Porter

Signature of Attorney

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May 18, 2004

Docket F-3278C PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of: Skeem et al.

Serial No.: 08/892,836 Group No.: 3723

Filed: July 17, 1997 Examiner: G.Nguyen

For: Metal Single Layer Abrasive Cutting Tool Having a Contoured Cutting Surface

Commissioner for Patents
P.O. Box 1450
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Sir:

APPEAL BRIEF

Real Party in Interest

The real party in interest is Norton Company, now operating under the name, Saint-Gobain Abrasives, Inc., a Massachusetts corporation, having a principal place of business at One New Bond Street, Worcester, MA 01615-0138. Norton Company is the owner of the above-captioned patent application by assignments from the inventors. The assignments are recorded at reel 7981, frame 0063, and reel 8569, frame 0910 of the United States Patent and Trademark Office.

Related Appeals and Interferences

No related interferences known to appellant or to appellant's legal representative or assignee will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

This is the second appeal in the present application, the Examiner's rejection in the first appeal being affirmed-in-part and the application being remanded for further consideration by the Examiner following a request for rehearing.

Status of Claims

On March 31, 2004, Appellants appealed from the Final Rejection, mailed November 18, 2003, of claims 1, 5-7, 11-26 and 30-33. Claims 2 and 27 are withdrawn from consideration as being directed to a non-elected species. Claims 28-29 and 30 have been allowed and claims 3-4 and 10 are objected to as depending from rejected claims, but would be allowed if re-written in independent form, containing all of the limitations of their parent claims.

The claims on appeal are set forth in Appendix A annexed hereto. The claims withdrawn from consideration are set forth in Appendix B annexed hereto.

Status of Amendments

Appellants believe all amendments have been entered by the Examiner; however, amendments to claims 1, 13 and 30 submitted on August 27, 2003, were not addressed in the Examiner's rejection of November 18, 2003.

Summary of the Invention

The claimed invention relates to cutting tools comprising a single layer of superabrasive grains chemically bonded onto a monolithic substrate having a plurality of contoured teeth extending from a substrate surface.

The tools of the invention comprise a plurality of cutting levels of abrasive grains parallel to the substrate surface and oriented such that at least a portion of each cutting level of each tooth overlaps each of the other parallel cutting levels of the tooth. As a result of this structure, the bonded grains on the lower parallel cutting levels support the grains in the uppermost cutting level which are in contact with the workpiece during cutting. In addition, each tooth is contoured such that in the uppermost cutting level a ring of the abrasive grain around the contoured surface of each tooth is in contact with the workpiece during cutting. See page 8, lines 17-24, and the Figures. Further, as set forth

in independent claims 1, 13 and 30, the <u>first uppermost cutting level consists of bonded abrasive grain, whereas subsequent cutting levels as the tooth is worn comprise a ring of abrasive grain and bond, together with a portion of the tooth</u>. See page, 9, lines 20-25, Fig. 3 (grains 1); page 12, lines 8-14, Fig. 6 ("grains at uppermost cutting level 13 (those bonded to the top of each tooth 12)"); page 13, lines 3-11; and page 11, lines 3-17 and Figs. 3, 4 and 5 of Appellants' specification. This first cutting layer provides an initial aggressive cutting performance not observed in prior art tools. This, together with the steady state cutting performance from initial cut to full wear of the successive cutting layers of the teeth is illustrated in the Figure 1 plot of penetration rate over time.

The teeth on the tools of the invention preferably have a negative rake angle in the direction of motion. In certain embodiments, the teeth of the tools will have a negative rake angle in either a clockwise or a counterclockwise direction of motion (e.g., Fig. 2).

In most prior art tools comprising a single layer of abrasive grain, the grain has been adhered to a substrate by electroplating or some other physical bonding mechanism. The strength of a physical bond is significantly less than that of a chemical bond, such as the braze used to bond the abrasive grain to the tools of the invention.

To chemically bond diamond or CBN abrasive grain to a metallic substrate surface, the bonding agent is preferably an active braze or other composition comprising an element reactive with the carbon or the nitride on the surface of the grain. For example, preferred brazes contain a nickel-chromium material, or a bronze-titanium material. (See page 19, lines 9-17.) The grain must be bonded to the substrate at a temperature of about 1000-1100 °C for chromium or about 850-950 °C for titanium under an inert atmosphere to form a chemical bond between the abrasive grain and the metal

substrate. As a result of this chemical bond, the grains bear the majority of the cutting force load, the penetration rate of the tool is higher, the cut is freer and the steady state cutting rate equilibrium is extended, with maximum utilization of grain and tool life.

The physical structure of the tools of the invention provides the benefit of reduced undercutting. Undercutting is the premature wear of the steel or other substrate surface caused by contact with hard debris generated during cutting concrete, and the like, while the grain retains useful life. The tools of the invention are designed so that the ring of chemically bonded abrasive grain around each tooth on the lower levels of the plurality of overlapping cutting levels of abrasive grain functions as a surface guard against the undercutting of the metal support structure of the teeth. See page 8, lines 25-27 and page 9 and Figure 2. The only supporting structure exposed to the workpiece or its debris is the cross-sectional area of the tooth within the operative cutting level. This supporting structure is designed to wear as the grain wears to expose the next cutting level. Thus, grain and support wear rates are synchronized. See claims 13 and 30. As the cutting levels wear, the amount of protection remains constant until the lowermost cutting level is in use. See page 14. The design ensures initial aggressive cutting performance without the necessity of removing grains from the top of the teeth before initial use, full grain life, improved tool life and protection from loss of teeth due to undercutting during tool usage.

<u>Issue</u>

Whether claims 1, 3-26 and 30-33 are patentable under 35 USC Section 103(a) over U.S. Pat. No. 5,018,276 to Asada ("Asada"), in view of U.S. Pat. No. 3,894,673 to Lowder, et al. ("Lowder").

Grouping of Claims

Appellants consider each claim herein to be separately patentable.

Claim 1 is one of four independent claims. Claim 1 is directed to an abrasive cutting tool comprising a monolithic substrate having a plurality of contoured teeth extending from the substrate; a chemically bonded single layer of superabrasive grains on the teeth, the grains defining a plurality of overlapping cutting levels on each tooth; and a first uppermost cutting level of grains consisting of bonded grain, with successive cutting levels comprising grain, bond and a portion of the tooth, on each tooth. During cutting the first uppermost cutting level tool is worn away first, and, then, each successive uppermost cutting level presents to the workpiece a ring of grains around the contoured surface of each tooth, such that substantially all grains within the ring simultaneously engage in cutting. Claims 2-12 and 33 depend from claim 1.

Claims 3-4, 10, 14-16, 28-29 and 34 specify a preferred tooth design having a negative rake angle. These claims describe tool embodiments illustrated in Figures 3, 6, 7, 10 and 11. All claims in this group except for claims 14-16, directed to a method of cutting with a negative rake tool, have been allowed.

Claims 3, 4 and 6, and claims 16, 17 and 18 specify preferred grain placement and concentration on the surfaces of the teeth. In one embodiment (claims 3 and 16), the angle of inclination of the negative rake is no more than one-third of the percent concentration of grains bonded to the negative rake portion of the tooth (Figures 3, 6, 10 and 11). In another embodiment (claims 4, 6, 17 and 18), at least 50% of the successive cutting levels contain about the same number of grains (Figures 3, 7, 10 and 11).

Claims 7 and 19 specify preferred tooth designs of claims 6 and 18, respectively, wherein successive cutting levels having the same number of grains also have a constant cross sectional area. Claims 8 and 20 specify preferred tooth designs of claims 6 and 18, respectively, wherein upper successive cutting levels of each tooth have a smaller cross sectional area than lower cutting levels of each tooth (Figure 6). Claim 9 and 23 specify a preferred embodiment of claim 6 and 18, respectively,

wherein the successive cutting levels having the same number of grains comprises the lower 50% of the cutting levels of each tooth (Figures 3, 7, 10 and 11).

Claim 10 specifies the tool of claim 1 having a preferred trapezoidal tooth cutting surface. Claim 11 specifies the tool of claim 1 having a preferred abrasive grain content of less than 75% grain concentration. Claim 12 specifies the tool of claim 1 having a preferred tooth hardness of 38 to 42 Ra.

Claim 13, the second independent claim, is directed to a method of cutting with the tools of the invention wherein a constant force is achieved at the point of contact with the workpiece; effective cutting is achieved; and the rates of wear resistance of the teeth and fracture of the grain are approximately equal on the first uppermost cutting level. Claims 14-26 depend from claim 13.

Claim 21 specifies the method of claim 13 using a grain having a preferred grain strength index of at least one minute according to the FEPA standard for diamonds. Claim 22 specifies the method of claim 13 using a grain having a preferred abrasive grain size of about 100 to 600 microns. Claim 24 specifies the method of claim 13 using a preferred grain concentration of less than 75%. Claim 25 specifies the method of claim 13, wherein the workpiece is masonry having a Knoop hardness of at least 700 Rc. Claim 26 specifies the method of claim 13 using teeth having a hardness of 38 to 42 Ra.

Claim 28, the third independent claim, is directed to a group of tools basically as described in claim 1, but also having teeth with a negative rake angle. Claims 29 and 34 depend from claim 28. Claim 29 specifies a preferred design of claim 28 tools, wherein the uppermost 10% of each tooth comprises a face inclined at a negative rake angle with respect to the direction of movement.

Claim 30, the fourth independent claim, is directed to a tool having the basic geometry of the tools of claim 1 and exhibiting approximately equal rates of wear resistance in the substrate and teeth to fracture resistance in the abrasive grain at a given cutting level on the teeth. Claim 31 depends from claim 30.

Claim 31 specifies the tool of claim 30 using a grain having a preferred grain strength index of at least one minute according to the FEPA standard for diamonds. Claim 32 specifies the tool of claim 30 using teeth having a hardness of 38 to 42 Ra.

Claims 33 and 34 depend from claims 1 and 28, respectively, and specify a preferred class of tools (e.g., saw blades) having the structural attributes of the invention.

In summary, there are four independent sets of claims, with a variety of preferred embodiments recited in 30 dependent claims, and these claims do not stand or fall together.

Argument

Appellants' claims 1, 3-26 and 30-33 are patentable under 35 USC Section 103 over the Asada reference, in view of Lowder.

The tools defined in amended independent claims 1, 13 and 30 are much more than just tools having a single layer of abrasive grain precisely placed on the teeth of a monolithic disc, or just tools made with chemically bonded abrasive grain, or just tools having negative rake angle cutting teeth. The presence of teeth having a first layer *consisting of bonded grain*, and successive ring shaped layers *comprising grain, bond and a portion of the tooth*, of chemically bonded single layer diamond grains is critical to the claimed tool initially aggressive and steady state cutting performance and this combination structure is neither disclosed nor suggested in the cited references.

The Asada Reference

The Asada reference, cited by the Examiner as the primary reference, discloses electroplated cutting tools in the form of saw blades having a monolithic substrate with cutting teeth and abrasive grain bonded to the teeth with electroplated metal.

The obvious functional shortcomings of electroplated single layer abrasive grain tools, relative to chemically bonded abrasive cutting tools, are demonstrated in the laboratory tests described in the Second Declaration of inventor Buljan. A copy of his declaration is annexed hereto as Appendix C.

Furthermore, Asada cannot be read to teach a structure having a <u>first</u> uppermost cutting layer <u>consisting of bonded abrasive grain</u>. The Asada structures shown in Figures 1 and 6 comprise grain and bond around the perimeter of the tooth, together with <u>the tooth material itself</u> (e.g., steel) at a 'first uppermost cutting level,' and the performance of the Asada tool (see Figure 11) bears witness to such an observation. Asada's "prior art" tools shown in Figures 8, 9 and 10, which Asada cautions us not to make or use (see col. 1, lines 21-43; col 2, lines 52-56 and 60-6; and col. 3, lines 38-46), do have a layer consisting of bonded abrasive grain corresponding to Appellants' claimed first uppermost cutting layer. Asada states one must remove the grain from the top surface of the tooth. Asada literally teaches away from structures described in Appellants' claims.

In his rejection, the Examiner alleges that Asada discloses "...the layer being electroplated to at least a portion of the surface of each tooth to define a plurality of cutting levels parallel to the substrate surface, and each cutting level on each tooth being oriented such that a portion of each cutting level overlaps at least a portion of each other cutting level of the tooth...". The Examiner fails to cite a particular column and line of text in Asada where this alleged disclosure can be found because no such text exists in the Asada reference. One cannot infer such a construction from the Figures in Asada, because Asada teaches the abrasive grain must be electroplated to the teeth. A well

documented disadvantage of electroplated diamond tools is the ease with which the electroplated metal can be peeled away or stripped from the metal core when force is applied to the cutting diamonds physically held within the electroplated layer. In other words, one cannot assume the construction "*...each cutting level on each tooth being oriented such that a portion of each cutting level overlaps at least a portion of each other cutting level of the tooth...*" will automatically occur on ***each tooth*** of an electroplated tool. All or some of the electroplated bond will peel off of at least some of the teeth as the tool is used. Thus, Asada does not disclose what the Examiner has alleged and obviousness cannot be obtained from the Examiner's hindsight reconstruction of the reference. Appellants' claim limitations cannot be read into the Asada reference where they do not exist.

With respect to claims 13 and 30, the Asada design fails to provide the initial high penetration cutting followed by steady state cutting conditions of the sort described in Appellants' text on page 11, lines 17-25, and Fig. 2. The Asada design cannot provide high initial cutting rate conditions because Asada has removed the first layer of abrasive grain from the top of the teeth and it is this top of the tooth grain layer that contributes the initial aggressive cut in Appellants' tools. Compare Figure 11 of Asada to Figure 2 of Appellants' application. Evidence of the deficient initial cutting performance of the Asada tools also is presented in the Buljan declaration (Appendix C).

<u>The Lowder Reference</u>

Lowder was cited as evidence of knowledge in the art of the benefits of a chemically active bond in single layer abrasive grain tools. Lowder is silent regarding tool geometry, steady state cutting rates, freedom of cut and other structural limitations and

functional attributes of Appellants' claimed invention. It contains no suggestion to use negative rake angle teeth coated with abrasive grain or to otherwise combine the various structural limitations of Appellants' invention with a chemically reactive bond.

Obviousness Analysis

The standard for obviousness is set forth in MPEP 706.02(j) and In re O'Farrell 7 USPQ2d 1673 (CAFC 1988). The MPEP *prima facie* obviousness rejection requires the presence of three elements in the prior art. First, there must be a suggestion or motive in the references or in the general knowledge in the art to modify the references or to combine the references. Second, there must be a reasonable expectation of success in making such a combination or modification. Third, the art must teach or suggest all claim limitations.

Here, the Examiner's rejection lacks portions of the first and second elements and fails to heed that the art does not teach or suggest all claim limitations. In particular, the "first uppermost cutting level of grain consisting of grain and bond" on the teeth of a monolithic core is absent from the references.

Asada, in view of Lowder, might suggest to one skilled in the art that tool life could be extended by substituting diamond attached with a braze having a chemically reactive component for the electroplated diamond of Asada. However, Lowder (1975) was available to Asada (1989) and Asada ignored the possibility of using a reactive braze, or even a braze, and instead teaches the grain should be electroplated to the core of the tool. One skilled in the art may assume Asada rejected Lowder's teachings for some unstated and, therefore, unknown reason. Asada, in view of Lowder, would not suggest the benefits of including a first cutting level consisting of bonded abrasive grain on the

teeth of the Asada tool and would not suggest the benefits of controlling the location and concentration of abrasive grain on the teeth.

Furthermore, Appellants' invention includes other benefits, such as free cutting operation ("high penetration rate"), initially high cutting performance, and steady state cutting operation over much of the tool life. See page 2, last two lines and page 3, first 2 lines, and Figures 1 and 2 of Appellants' specification.

Asada, in view of Lowder, fails to suggest these benefits. As demonstrated in the Buljan declaration, the electroplated tool of Asada having no grain on the outer perimeter of the teeth requires more time to make an initial cut than the tools of the invention and, therefore, lacks the free cutting character of the tools of the invention. This benefit of the invention was observed in the Buljan experiment irrespective of whether the teeth of the tool of the invention were made with a negative rake angle (claims 3-4, 10, 14-16, 28-29 and 34) or without a negative rake angle (claims 1, 5-9, 11-13, 17-26 and 33).

The initial stage of the steady state, freely cutting character of the tool of the invention is due principally to the presence of "a first uppermost cutting level consisting of grain and bond." This first layer is forbidden by the Asada patent, leaving no expectation of success in Appellants' invention. (See Figures 7-12, and col. 2, lines 10-22, of Asada.)

Other structural aspects of the tools of the invention are likewise absent from the combined cited references. The tooth geometry and/or the tool type shown in Appellants' Figures 6-9 and 11-12 are not disclosed or suggested. In particular, the references fail to mention core drills: a tool type likely to benefit from high penetration rate and steady state cutting operations, as well as from enhanced tool life.

For these reasons, the rejection fails to state a *prima facie* case of obviousness. Appellants' combination of structural and material features causes a new and useful result not suggested by Lowder or Asada, individually, nor in combination. It is only with the hindsight gleaned from Appellants' invention that the obviousness rejection has been made over the cited art. Hindsight is not a permissible basis for an obviousness rejection. Uniroyal v. Rudkin-Wiley, 5 USPQ 2d 1434 (Fed. Cir., 1988).

CONCLUSION

In view of the remarks set forth herein, and the remarks of record, Appellants respectfully request a reversal of the rejection and a remand for an allowance of all claims pending in the application.

Respectfully submitted,

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May 18, 2004

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Docket
F-3278

Claims on Appeal
Ser. No.: 08/892,836
Filed: 7/15/97
Skeem, et al

1. An abrasive cutting tool comprising:

a) a monolithic substrate having a substrate surface with a plurality of teeth extending therefrom, each tooth having a contoured surface,

b) a layer comprising superabasive grains, the layer being chemically bonded to at least a portion of the surface of each tooth to define a plurality of cutting levels parallel to the substrate surface, and each cutting level on each tooth being oriented such that a portion of each cutting level overlaps at least a portion of each other cutting level of the tooth; and

c) a first uppermost cutting level consisting of bonded superabrasive grains, and successive uppermost cutting levels, comprising bonded superabrasive grains and a portion of the tooth, among the plurality of cutting levels of each tooth;

whereby after the first uppermost cutting level has been worn away by cutting a workpiece, each successive uppermost cutting level of the tooth presents to the workpiece a ring of superabrasive grain around the contoured surface of the tooth, and substantially all superabrasive grain within the ring simultaneously engages in cutting.

3. The tool of claim 1 wherein the substrate surface has an intended direction of movement, wherein at least a portion of each tooth has a face which is inclined at a negative angle with respect to the intended direction of movement, and at least a portion of the grains are bonded to the face having the negative angle of inclination.

4. The tool of claim 3 wherein the grains bonded to the face having the negative angle of inclination are present in a concentration wherein the angle of inclination in degrees is no more than 1/3 of the grain concentration in percent.

5. The tool of claim 1 comprising successive cutting levels comprising at least 50% of the plurality of cutting levels, wherein each cutting level of the successive cutting levels contains about the same number of grains.

6. The tool of claim 1 wherein a portion of each tooth is associated with successive cutting levels comprising at least 50% of the cutting levels of the tooth, and wherein each cutting level of the successive cutting levels contains about the same number of grains.

7. The tool of claim 6 wherein the portion of each tooth associated with the successive cutting levels having about the same number of grains has a constant cross section.

8. The tool of claim 6 wherein the portion of each tooth associated with the successive cutting levels having about the same number of grains has an uppermost cross section and a lowermost cross section, and the uppermost cross section is smaller than the lowermost cross section.

9. The tool of claim 6 wherein the successive cutting levels having about the same number of grains comprise at least the lowermost 50% of the cutting levels of each tooth.

10. The tool of claim 9 wherein the substrate surface has an intended direction of movement, wherein at least the uppermost 10% of each tooth has a face which is inclined at a negative angle with respect to the intended direction of movement, and at least a portion of the grains are bonded to the face having the negative angle of inclination, thereby producing a trapezoidal cutting surface.

11. The tool of claim 1 wherein the concentration of the grain is less than 75%.

12. The tool of claim 1 wherein the teeth have a hardness of between about 38 and 42 Ra.

13. A method of cutting, comprising the steps of:

a) providing an abrasive cutting tool comprising:

i) a substrate surface having a plurality of teeth extending therefrom, each tooth having a surface, and

ii) a layer comprising abrasive grains, the layer being chemically bonded to at least a portion of the surface of each tooth to define a plurality of cutting levels parallel to the substrate surface, the cutting levels comprising a first uppermost cutting level, consisting of bonded abrasive grains, and a second uppermost cutting level, comprising bonded abrasive grains and a portion of the tooth, the grains having a predetermined wear resistance,

b) moving the substrate surface in an intended direction of rotation,

c) contacting the uppermost cutting level of at least one tooth to a workpiece at a point of contact,

d) applying a constant force to the tool directed at the point of contact,

wherein the constant force is sufficient to cut the workpiece, the strength of the bond is sufficient to resist peeling, the predetermined wear resistance of the grains is such that the grains of the first uppermost cutting level fracture under application of the constant force, and the wear resistance of the teeth are such that the portion of the tooth associated with the first uppermost cutting level wears at about the same rate as the grains of the first uppermost cutting level fracture,

thereby causing essentially simultaneous removal of the grains of the first uppermost cutting level from their bond and the portion of the tooth associated with the first uppermost cutting level, and

thereby exposing the grains of the second uppermost cutting level to the workpiece.

14. The method of claim 13 wherein the plurality of teeth includes successive teeth having successively lower uppermost cutting levels in the intended direction of

movement, thereby producing a cutting surface having a negative angle of inclination with respect to the intended direction of movement.

15. The method of claim 13 wherein at least a portion of each tooth has a face which is inclined at a negative angle with respect to the intended direction of movement, and at least a portion of the grains are bonded to the face having the negative angle of inclination.

16. The method of claim 15 wherein workpiece produces abrasive swarf when cut, and wherein the grains bonded to the face having the negative angle of inclination are present in a concentration wherein the angle of inclination in degrees is no more than 1/3 of the grain concentration in percent, thereby protecting the grains of the uppermost cutting level from undercutting.

17. The method of claim 13 comprising successive cutting levels comprising at least 50% of the plurality of cutting levels, wherein each cutting level of the successive cutting levels contains about the same number of grains.

18. The method of claim 17 wherein a portion of each tooth is associated with successive cutting levels comprising at least 50% of the cutting levels of the tooth, and wherein each cutting level of the successive cutting levels contains about the same number of grains.

19. The method of claim 18 wherein the portion of each tooth associated with the successive cutting levels having about the same number of grains has a constant cross section.

20. The method of claim 18 wherein the portion of each tooth associated with the successive cutting levels having about the same number of grains has an uppermost

cross section and a lowermost cross section, and the uppermost cross section is smaller than the lowermost cross section.

21. The method of claim 13 wherein the grain toughness is characterized by a relative strength index of at least one minute, as measured by the FEPA standard for measuring the relative strength of saw diamonds.

22. The method of claim 13 wherein the grain size is between about 100 um and 600 um.

23. The method of claim 18 wherein the successive cutting levels having about the same number of grains comprise at least the lowermost 50% of the cutting levels of each tooth.

24. The method of claim 13 wherein the concentration of the grain is less than 75%.

25. The method of claim 13 wherein the workpiece is masonry having a Knoop hardness of at least 700 Rc.

26. The method of claim 13 wherein the teeth have a hardness of between 38 Ra and 42 Ra.

28. (Twice amended) An abrasive cutting tool comprising:

a) a monolithic substrate having a substrate surface with a plurality of teeth extending therefrom, each tooth having a contoured surface,

b) a layer comprising abrasive grains, the layer being chemically bonded to at least a portion of the surface of each tooth to define a plurality of cutting levels parallel to the substrate surface, and each cutting level on each tooth being oriented such that a portion of each cutting level overlaps at least a portion of each other cutting level of the tooth; and

c) a first uppermost cutting level and successive uppermost cutting levels comprising superabrasive grains among the plurality of cutting levels of each tooth; wherein the substrate surface has an intended direction of movement, wherein at least a portion of each tooth has a face which is inclined at a negative angle with respect to the intended direction of movement, and at least a portion of the abrasive grains are bonded to the face having the negative angle of inclination, and whereby after the first uppermost cutting level has been worn away by cutting a workpiece, each successive uppermost cutting level of the tooth presents to the workpiece a ring of superabrasive grain around the contoured surface of the tooth, and substantially all superabrasive grain within the ring simultaneously engages in cutting.

29. The tool of claim 28 wherein at least the uppermost 10% of each tooth comprises the face which is inclined at a negative angle with respect to the intended direction of movement.

30. An abrasive cutting tool comprising:

a) a substrate surface having a plurality of teeth extending therefrom, the teeth having a surface and a predetermined wear resistance, and

b) a layer comprising abrasive grains, the layer being chemically bonded to at least a portion of the surface of each tooth to define a plurality of cutting levels parallel to the substrate surface, the cutting levels comprising a first uppermost cutting level consisting of bonded abrasive grains, and the grains having a predetermined wear resistance,

wherein the wear resistance of the teeth and the wear resistance of the grains are predetermined such that, when a given cutting level contacts a workpiece under an optimum load, the grains of the given cutting level wear and fracture at about the same rate as the portion of the tooth associated with the given cutting level wears away.

31. The tool of claim 30 wherein the teeth have a hardness of between 38 Ra and 42 Ra.

32. The tool of claim 31 wherein the grains have a relative strength index of at least one minute, as measured by the FEPA standard for determining the relative strength of saw diamonds.

33. The abrasive cutting tool of claim 1, wherein the tool is selected from the group consisting of saw blades, core drills and abrasive wheels.

34. The abrasive cutting tool of claim 28, wherein the tool is selected from the group consisting of saw blades, core drills and abrasive wheels.

Docket
F-3278C

Claims Withdrawn from Consideration
Directed to a Non-elected Species
Ser. No.: 08/892,836
Filed: 7/15/97
Skeem, et al

2. The tool of claim 1, wherein the substrate surface has an intended direction of movement and wherein the plurality of teeth includes successive teeth having successively lower uppermost cutting levels in the direction of the intended direction of movement, thereby producing a cutting surface having a negative angle of inclination with respect to the intended direction of movement.

27. An abrasive cutting tool comprising:

a) a substrate surface having a plurality of teeth extending therefrom, each tooth having a surface and

b) a layer comprising abrasive grains, the layer being chemically bonded to at least a portion of the surface of each tooth to define a plurality of cutting levels parallel to the substrate surface,

wherein the substrate surface has an intended direction of movement, wherein the plurality of teeth includes successive teeth having successively lower uppermost cutting levels in the direction of the intended direction of movement, thereby producing a cutting surface having a negative angle of inclination with respect to the intended direction of movement.

Docket Number F-3278C

Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Skeem, et al

Serial Number: 08/892,836 Examiner: G.Nguyen

Filed: 7/15/97 Group Art Unit: 3723

For: Metal Single Layer Abrasive Having a Contoured Cutting Surface

The Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

SECOND DECLARATION UNDER 37 CFR Section 1.132 of Inventor Sergej-Tomislav Buljan

1. I am a named inventor of the above-captioned patent application and I make this declaration in support of the patentability of the application over cited references U.S. Pat. No. 5,018,276 to Asada ("Asada"), U.S. Pat. N. 5,492,771 to Lowder, et al, ("Lowder") and U.S. Pat. No. 5,215,072 to Scott ("Scott").

2. I have a PhD in Solid State Science from The Pennsylvania State University, and over 30 years of experience in research and development working with a variety of materials. I presently hold the position of Manager, Superabrasives Research and Development, at Norton Company where I have worked in research and development relating to superabrasives and metal bonded cutting and grinding tool technologies for over 5 years.

3. Attached to my declaration as Appendix A are drawings of 4 diamond saw blades: 280, 277, 278 and E-plated. These 4 blades represent the following designs:

280: blade of the invention without negative rake (0° rake angle)

277: blade of the invention with negative rake

278: blade with negative rake having abrasive grain in successive rows rather than in successive rings around the teeth (representative of Scott cutting elements having rows, rather than rings of grains at a negative rake)

E-plated blade representing Asada design of equilateral teeth geometry and electroplated grain

4. All blades were made to 230 mm in diameter with 35/40 mesh, grade SDA 100+ mesh diamond grain bonded to a stainless steel cores of the same thicknesses and type. Nickel was used to electroplate grain for the E-plated sample. A chemically reactive braze containing a Cu-Sn-Ti alloy was used to bond the abrasive grain to the core in samples 280, 278 and 277.

5. Blades were mounted on a Bosch GWS 24-230 JC-2400W-6500RPM-max. electric saw for testing. An operator used this saw to make the following test cuts for each blade:

LEVEL 1. Soft Cement Brick.- 50 Cuts, 7 cm deep, 24cm long.

LEVEL 2. Abrasive Concrete Slabs.- 50 Cuts, 4 cm deep, 30 cm long.

LEVEL 3. Hard Concrete Slabs (Washed Concrete).- 30 Cuts, 2 cm deep, 25 cm long.

LEVEL 4. Hard Concrete Slabs (Washed Concrete).- 30 Cuts, 5 cm deep, 25 cm long.

6. Observations of cutting time for one pass and wear of the saw were made for the blades during the 4 levels of cutting tests. Measurements recorded included: (1) Speed of Cutting (Time required to complete 1 cut) and (2) Wear (Reduction in the blade radius). Experimental observations are summarized in the Table below.

Table 1 Cutting Test Results

	Sample 280	Sample E-Plated	Sample 278	Sample 277
Level 1				
Cutting time (s) ,1 pass.	3.00s	3.70s	4.16s	3.00s
Wear (mm)	0.0277 mm	0.0877 mm	0.2488 mm	0.0400 mm
Level 2				
Cutting time (s) ,1 pass.	8.00s	Stopped Cutting	8.00s	7.33s
Wear (mm)	0.0166 mm	Before 30 cuts.	1.5366 mm	0.0188 mm
Level 3				
Cutting time (s) ,1 pass.	12.42 s		Stopped Cutting	6.28s
Wear (mm)	0.0220 mm		after 23 cuts	0.0190 mm
Level 4				
Cutting time (s) ,1 pass.	Stopped Cutting			Stopped Cutting
Wear (mm)	after 3 cuts			after 9 cuts

7. These cutting test results demonstrate the following:

a) Electroplated blades of Asada are substantially inferior to chemically bonded blades of the invention in blade life.

b) Blades representative of Scott's design having rows of abrasive grain at a negative rake (278) are substantially inferior in blade life to blades of the invention having rings of abrasive grain either with (277) or without (280) a negative rake.

c) A negative rake angle is merely a preferred, and not an essential, embodiment for achieving the wear resistance and significantly prolonged tool life attributes of the tools of the invention.

8. Relative to the tools of the invention, the Scott tools are expected to yield a performance even more inferior than shown in these cutting tests because the Scott tools do not contain diamond abrasive chemically bonded to the mesh of the substrate.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that the statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

______________________________ Date: 11/25/98

Sergej-Tomislav Buljan, PhD

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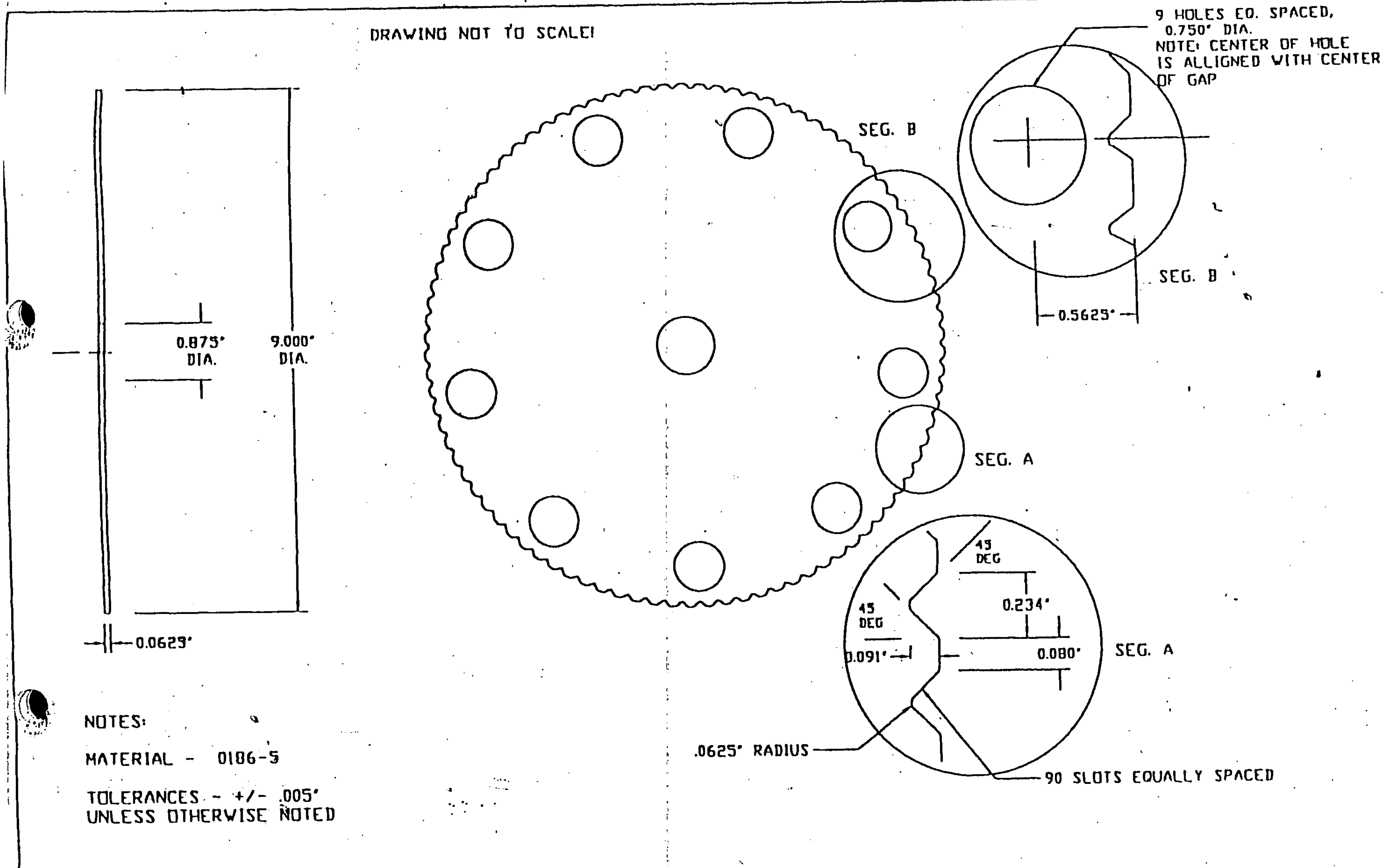


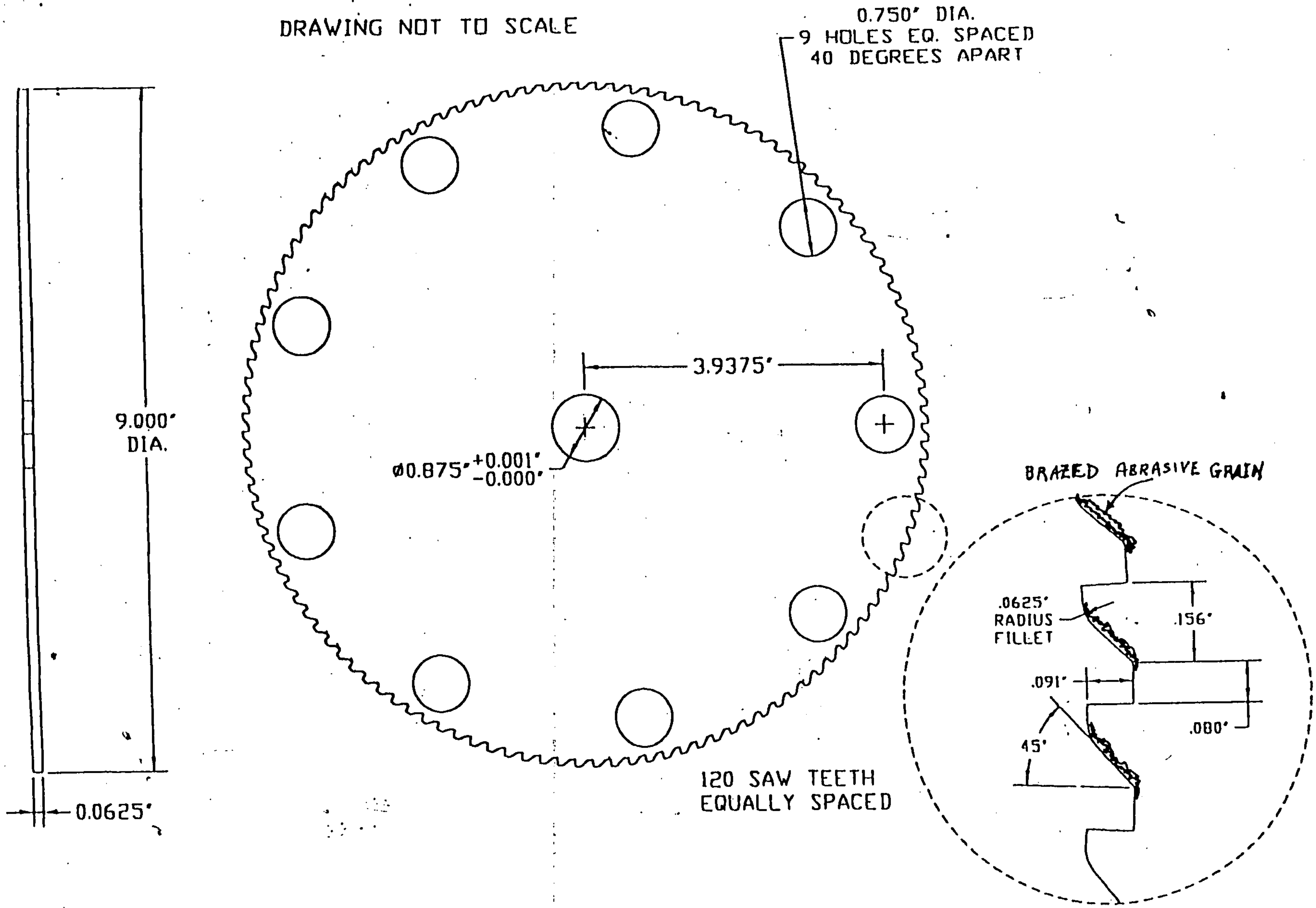
NOTES:

MATERIAL - 0186-5

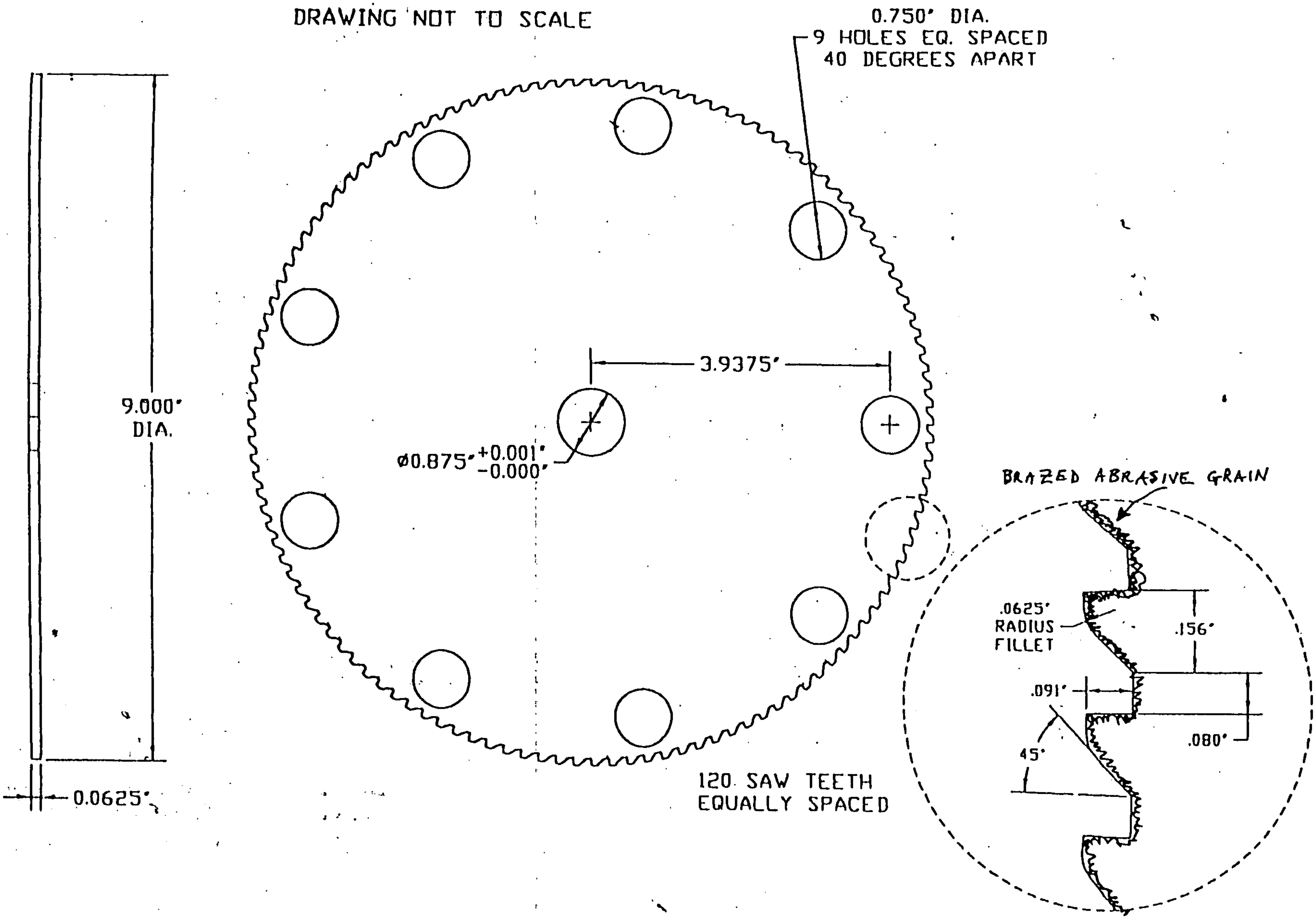
TOLERANCES - +/- .005"
UNLESS OTHERWISE NOTED

	NORTON COMPANY
	CONFIDENTIAL
	DWG.# 280

DRAWING NOT TO SCALE



NOTES: MATERIAL: 86SS TOLERANCES: +/- .005" UNLESS OTHERWISE NOTED	CONFIDENTIAL	NORTON COMPANY DWG.# 278



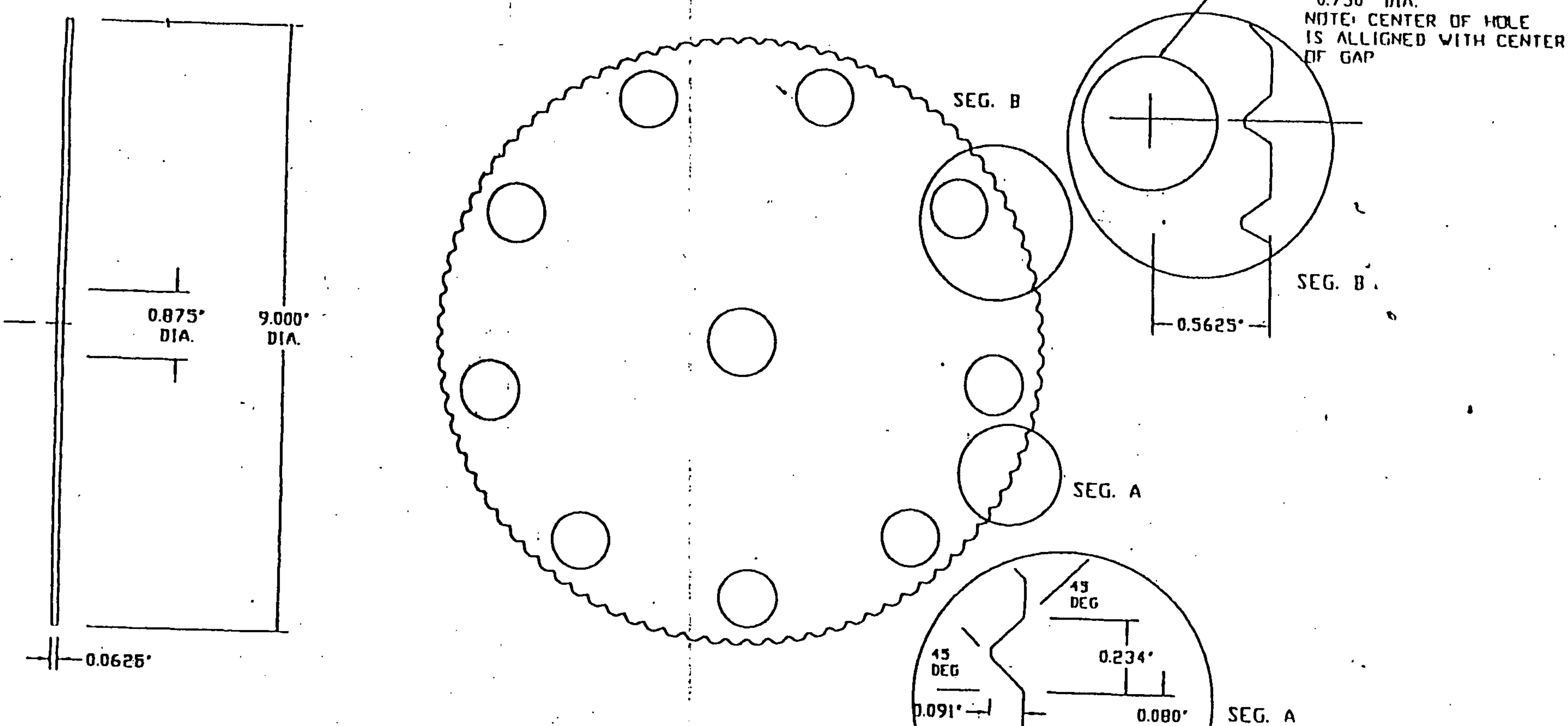
NOTES: MATERIAL: 86SS
TOLERANCES: +/- .005"
UNLESS OTHERWISE NOTED

CONFIDENTIAL

NORTON COMPANY

DWG.# 277

DRAWING NOT TO SCALE!



NOTES:

MATERIAL - 0186-5

TOLERANCES - +/- .005"
UNLESS OTHERWISE NOTED

NORTON COMPANY

CONFIDENTIAL

DWG.# E-plate